Development of Contribution Functions for Cladding

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INTRODUCTION

- Loss Optimization Seismic Design (LOSD) has been proposed for use in engineering practice to explicitly consider losses arising from repair, downtime, and injuries in the design phase.
- Component-level contribution functions, which estimate the repair cost normalized by the storey replacement cost of a building component subjected to a given engineering demand parameter, are required to aid engineers in performing simplified seismic loss estimation within the LOSD framework.
- Contribution functions are developed by combining quantity distributions, fragility functions, and repair cost; and example of which as shown in Figure 1 for interior partition walls.

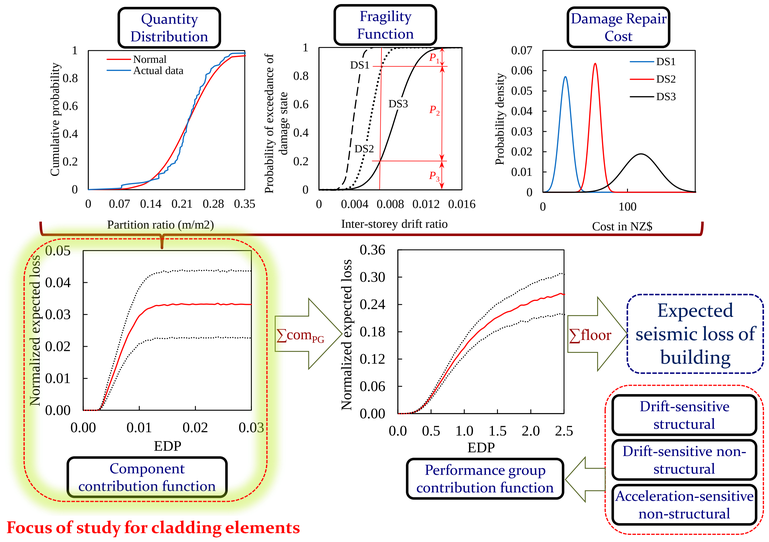

Figure 1. Computation of seismic loss from component level to building level (example for partitions) (Dhakal & Saha 2016)

METHODOLOGY

This project comprises of four main phases:

1. Conduct building survey to identify common types and density of claddings for residential, commercial, and industrial buildings in Christchurch.
2. Source/develop fragility functions for the most common cladding types used in practice.
3. Conduct surveys with contractors to obtain damage repair cost data.
4. Use the data collected from the steps above to develop contribution functions for cladding using Monte Carlo simulations.

RESIDENTIAL BUILDING

- The three most common types of cladding used in residential buildings are masonry, monolithic, and lightweight. The median length of cladding used per m^2 of floor area is 0.199 m with a dispersion of 0.17.

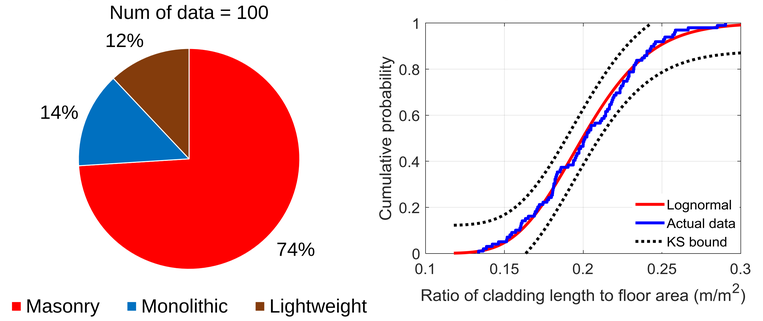

Figure 2. Common types of cladding (left), and distribution of cladding (right)

Figure 3. Masonry (left), monolithic (middle), and lightweight (right)

COMMERCIAL BUILDING

- The three most common types of cladding used in commercial buildings are glazing, lightweight, and precast. The median length of cladding used per m^2 of floor area is 0.179 m with a dispersion of 0.64.

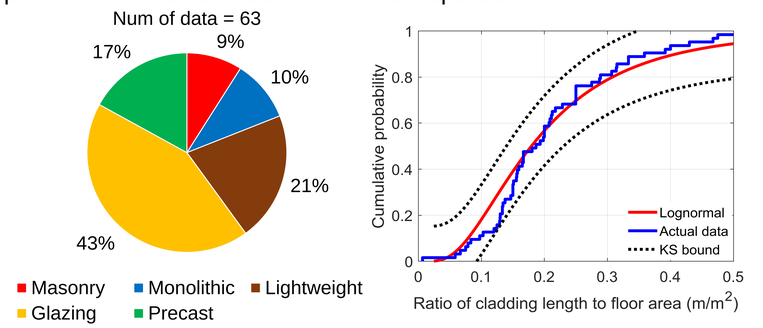

Figure 4. Common types of cladding (left), and distribution of cladding (right)

Figure 5. Glazing (left), lightweight (middle), and precast (right)

INDUSTRIAL BUILDING

- The three most common types of cladding used in industrial buildings are lightweight, monolithic, and precast. The median length of cladding used per m^2 of floor area is 0.078 m with a dispersion of 0.67.

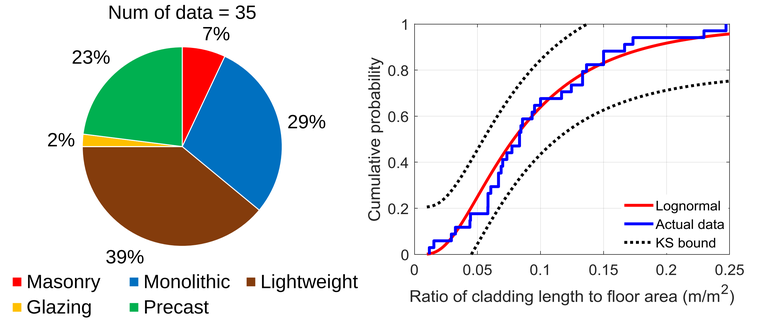

Figure 6. Common types of cladding (left), and distribution of cladding (right)

Figure 7. Lightweight (left), monolithic (middle), and precast (right)

CURRENT WORK

- Fragility functions for masonry, lightweight and monolithic cladding elements are currently being sourced or developed. Other cladding types have already been sourced; such as glazing as shown in Figure 8.
- Questionnaires have been sent to a wide range of building contractors regarding common detailing used in practice and damage repair cost. We are currently awaiting their response.

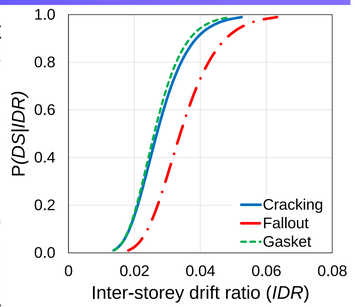

Figure 8: Typical fragility function for glazing (Brien et. al., 2012)

SUMMARY

- Survey has been conducted to identify common types and density of claddings used for a range of building usage types.
- Surveys underway to obtain damage-repair cost data.
- Findings will be combined with fragility functions to develop contribution functions for cladding.

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